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ABSTRACT

A nonexperimental ex post facto comparative study in the Jackson Area Career Center (Michigan) determined the correlation between basic skills grade levels indicated by standardized tests and success or failure in auto mechanics classes. In addition, the study determined whether the grade level of achievement in basic skills is correlated with employee/employer job satisfaction in related occupations. The literature review showed a correlation among basic skills, automotive classroom performance, and success on the job as an automotive technician and related areas. An examination of the reading and mathematics grade levels of 150 students was done over a 5-year period. The scattergram and the Pearson r correlation coefficient determined the relationships between the independent and dependent variables. Those students who entered auto mechanics or related occupations had the highest levels in basic skills and were satisfied with their jobs. There was a link between grade levels in basic skills and auto mechanics grades and job satisfaction. Math levels were less positively related to auto mechanics grade and job satisfaction; reading was more positively significant. In auto class, there was more emphasis on reading skills than math skills. (Four appendices--the questionnaire, textbook examples, data tables, and lesson ideas--and 16 references are included.) (NLA)

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A COMPARISON OF SECONDARY STUDENTS ADEQUATELY AND INADEQUATELY PREPARED IN BASIC SKILLS WITH REGARDS TO SUCCESS IN JACKSON AREA CAREER CENTER AUTO MECHANICS TRAINING AND A RELATED OCCUPATION

by

Mario Provenzano

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Masters of Science in Occupational Education
in the School of Education
at
Ferris State University
1990

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CHAPTER ONE
The Problem

Introduction

The Jackson Area Career Center is located at 6800 Browns Lake Road. It was voted into existence in 1976, with the intent to serve the needs of the students of Jackson County who have the desire to explore technical training for an occupation.

The institution serves 12 Jackson County High Schools which range on a state ranking from Class C to Class A. These schools are entitled to send up to 80 students, combined, per semester to the automechanics classes on a "first come first serve" basis. Over the past five years initial enrollment has been near capacity but by the end of the semester various attrition factors result in an average retention rate of 63 students.

Jackson County is a basically a blue collar work environment with an emphasis on automotive parts production. It was even more so in the past than it is today. Within the last five years, such major plants as Goodyear and Walker have ceased production. Other automotive parts plants such as Kent Moore and Kelsey Hayes have drastically reduced production.

The Career Center has always had good financial support from the community. It has never had a millage turned down.

Statement of Need

The automotive industry is changing. Since 1980, the occupation of automobile mechanics and the related areas has been undergoing great transformation because the technical characteristics of the

automobile are changing. Allen (1984) states the days of the "back-yard-mechanic" are gone:

> It used to be that a talented car mechanic could learn repairs by diagnosing with his senses--taking the auto apart, seeing what was broken and fix it. As more computers, electronics, sensors and other complex systems are put into cars the mechanic has to become more sophisticated in his approach.[1]

The advanced technology today has increased the requirements for competency by the student in the basics skills of math and reading. More than ever it is important for students to be able to read and understand, often complex directions, and perform the tasks from instructional text books and manuals if they are going to be successful in automechanics and the related occupational areas. If the philospophy and goals of the Jackson Area Career center were perceived as being met, there would be no reason to investigate this issue, but on the surface, the students enrolled in the automechanics classes do not seem to be living up to the Career Center's philosophy or achieving the stated goals. The philosophy as stated in the Jackson Area Career Center Handbook is:

> The Jackson Area Career center is dedicated to the belief that the occupations that contribute to society should be endowed with basic dignity and worth; that all human beings can learn and that all feelings and sensibilities which can enhance or detract from their ability to profit from instruction. High school students require a broad program of general education which allows them to explore and prepare for occupations appropriate for them, develops their citizenship potential and encourages their participation in cultural aspects of life. In addition, present and future labor markets are increasingly requiring individuals to develop some specific employment skills before they can enter the labor market.[2]

More importantly, a vital goal stated in the Handbook of the Career Center is, "To provide students with the skills which they can utilize

in employment or further education to meet the needs of the individual as related to the needs of the business community."[3]

Two very important concepts are forwarded in the philosophy and goals statements. First, automechanics should instill a sense of "dignity and worth." Second, there should be adequate training in automechanics skills which a student "can utilize in employment or further education" for employment.

What appears to be a contradiction is that the students enrolled in automechanics classes believe the automotive shop is a place were they are *discarded* because they are not adequately prepared in basic skills to perform in the "academic setting." The "Student Questionnaire," in *Appendix A*, was given to all students enrolled in automechanics over the last two and one half years. The purpose was to determine if the students also perceived a problem of academic preparation and job placement. This attitude embedded into their self-esteem is counter productive to their success and goals. It would appear the students are set up for failure and they could "live down" to that expectation. The questionnaire reveals a greater sense of "dignity and worth" could be associated with the automotive program at the Jackson Area Career Center.

Also, according to the academic standards and goals of the two automechanics instructors, the two instructional technicians, and one administrator closely involved, the automotive classes are perceived as experiencing a disproportionate number of students who are borderline or outright failures in cognitive and manipulative skills. This is evidenced by perceived poor performance in the class room and poor job placement in the real world. It would seem that

performance in the automotive classes should be related to job placement and success.

In short, this investigation should help determine if there is any correlation between inadequate performance in automechanics classes and related occupations and below average grade levels in basic skills.

Purpose of the Study

The purpose is to determine if there is any correlation between basic skills grade levels indicated by standardized tests and success or failure in automechanics classes. In addition, the study will determine whether or not the grade level of achievement in basic skills indicated by standardized tests is correlated with employee/employer job satisfaction in related occupations.

Delineation of the Research Problem

The question to be studied is whether students may fail to achieve in automechanics training because they under achieve in the basic skills of reading and mathematics.

The manuals students are expected to read to support cognitive and manipulative skills become more complex each year, and they require good concentration skills, exact comprehension ability, and the ability to apply what is read (See *Appendix B* for current examples of texts and manuals). Good mathematical skills also have become a crucial part of the modern auto technician's toolbox. With the advent of onboard computers and complex diagnostic machines, it is difficult, if not impossible, to solve many of the modern automobile's problems without a fundamental competency in mathematics.

If the above is true, the independent variables--the student's grade levels in reading and mathematics should strongly correlate with the dependent variables--the student's success in automechanics classes and job satisfaction in a related area. It is intended that this study will examine these relationships.

Questions to be Answered

1. Is there any correlation between student grade level in mathematics as measured by a standardized test and success or failure in automechanics class?
2. Is there any correlation between student grade level in reading as measured by a standardized test and success or failure in automechanics class?
3. Is there any comparison between the mean grade levels of basic skills and the mean automotive grades achieved by all students, non-job related students, and job related students?
4. Is there any correlation between student grade level in mathematics as measured by a standardized test and job satisfaction as perceived by the employee?
5. Is there any correlation between student grade level in reading as perceived by a standardized test and job satisfaction as measured by the employee?

Definition of Terms

The following terms are defined to clarify their use in the context of the study:

1. *Secondary students* shall be defined as those students in the 10th, 11th, or 12th grade in high school.
2. *Basic skills* shall be defined as reading, mathematics, and those areas related to and taught in conjunction with reading and mathematics.
3. *Adequately prepared* shall be defined as achieving a grade level equal to the current student grade placement on standardized math and reading tests administered by the the Jackson Area Career Center.
4. *Inadequately prepared* shall be defined as achieving a grade level score on a standardized test administered by the Jackson Area Career Center below the current student grade placement.
5. *Related occupations* shall be defined as any occupation in the automotive field that requires *fundamental skills* to solve problems related to the automotive repair industry.
6. *Job satisfaction* shall be defined as any aspect of the job including environment, nature of the work, pay, supervision or any other factor to be liked or disliked and shall be ranked by the employee on a continuum of "Very Dissatisfied (1), Dissatisfied (2), Somewhat Satisfied (3), Satisfied (4), and Very Satisfied
7. *Fundamental skills* shall be those skills taught in the automechanics classes.
8. *Standardized tests*, to determine grade level, shall be the *Shaw-Hiehle Computation* test for mathematics and the *Reading Progress Scale* for reading.

Scope and Delimitations of the Study

The study was conducted in view of the following limitations:

1. It is not always possible to follow all students' occupational success after they have been out of school for more than two years. Initial job placement can usually be determined but as the students move from job to job or unemployment line to unemployment line their progress is not recorded.
2. Job satisfaction on the part of the employee and employer is measured by the students' responses only. It was not possible to contact all immediate supervisors of the employee so rather than do an incomplete survey, it was decided to use the students' responses as valid. The rationale is that if the employee is satisfied with the job, the employer probably shares that satisfaction.
3. All students who, in the past, have enrolled into automechanics classes cannot be studied because they may have dropped for reasons unrelated to academics; therefore, only students who have taken the basic skills tests, received a final grade in automechanics classes, and have completed the *Vocational Education Data Systems* (VEDS) report will be studied.

Assumptions

The following four assumptions are made with respect to this study:

1. That entry level tests are reliable and valid and give accurate information with regard to entry level reading and mathematics skills.

2. That the grades given in automechanics classes are true indicators of success in those courses.
3. That it is possible to accurately assess job occupation satisfaction using employee measures.
4. That the Jackson Area Career Center is typical of other career centers in the State of Michigan.

CHAPTER II
Review of Related Literature

Organization

There is a considerable amount of literature dealing with basic skills and success in and out of the vocational classroom. The literature which correlates success in basic skills and in automechanics classes and related job occupations specifically is very sparse. This paper will, therefore, review the literature concerning the value of basic skills on a general vocational level, then proceed to the more specific information related to automechanics only.

Related Literature

Eash and Fitzgerald (1987) agree that basic skills are crucial to occupational success which is significant in revitalizing the economy of the United States:

> Occupational education has a major role in the revitalization the the country's economy through the upgrading of the training and retraining of a more productive work force. The two areas where occupational education curriculum can directly contribute to build a new competitive economy are through increasing achievement in basic skills and through the instruction of students in understanding and use of human systems innovation work environments. 4

It seems, therefore, there is a relationship to basic skills competency and the total success of the United States economy according to the above authors. Logically the United States can not have a strong competitive economy without a well trained, intelligent workforce.

Further witness for the importance of basic skills to work comes from Cox (1986):

> The strong message from employers and personnel responsible for post secondary education is that the primary basis for success in the world of work in vocational/technical education is proficiency in such basic skills as reading, writing, arithmetic, and reasoning, and that a great number of high school pupils lack proficiency in these areas.5

The above quote expresses the importance of reading and math related skills to the world of work. It is incumbent on our educational system to teach these skills. Cox (1986) continues to make a vital point that it is the job of the entire school system to teach these skills: "Another strong point is that vocational education and 'academic' education as separate endeavors are not likely (and likely cannot) meet the educational needs of pupils as those needs relate to our changing and expanding economy."[6]

Patton and Lawrence (1985) zero in more specifically by relating basic skills to vocational success in the class room and on the job. They define basic skills as "Reading , writing, computation, speaking, listening, and interpreting."[7] It is realized this is a expansion of our definition of "basic skills" (reading and math) as they are defined in this paper, but again, the additional areas listed are directly related to reading and math, and are taught in conjunction with those basic skills. Certainly, they all work together and have a major bearing on vocational success.

Two relevant observations drawn from their study are:

1. When compared to academic students, vocational students are less proficient in basic educational skills.
2. Basic skill proficiency is related to such outcomes as salary, employment area and employment level. [8]

The first conclusion tends to indicate the less proficient students in basic skills tend to migrate to vocational education classes, or they are placed into vocational education classes by counsellors, teachers or parents. The reason for migration could be an interest, or a perception that the work is easier and, therefore, something they can handle. If the students less proficient in basic skills are placed in vocational classes, it tends to presume something about the perception teachers, counselors or parents have concerning these students.

The second conclusion correlating basic skills to job level and salary seems to be equally important. The implication, at least, is that the better trained in basic skills a student is, the higher his job level and, therefore, the higher his salary.

From the preceding literature, it is apparent basic skills are needed for success in all general areas of vocational training. As previously stated, the literature relating automechanics and basis skills is sparse. Three articles were found after searching in excess of 100 articles in Educational Resources Information Center (ERIC), and two of these came from Industrial Education, a reputable magazine about industrial education but not given to the pedantic approach. The other article was "Final Report: Related Skills in the Marketplace., " sponsored by The Alabama State Department of Education.

The first article from Industrial Education (1989) offers opinions from reputable persons in the automotive industry. The first person is Lee Iacocca who begins by expressing his displeasure about not "...getting the number of quality graduates we want." [9] His company put a panel together to investigate the problem and determined it was

because it starts very early in the education system...at the very basic level. He goes further, stating:

> One of the things we are trying to do is keep the issue of educational reform on the national agenda President Bush has talked about. We feel that if there are some things we can do to keep it in people's minds and to help keep people involved, there is potential to actually revolutionize education.10

This statement indicates that Chrysler Corporation is getting under-educated personnel to work in the automotive field. Iacocca wants to dedicate the entire year of 1990 to better education.

Charles Groves Ford, Manager of Special Training Programs for the Ford Motor Company, strikes at what he sees as the heart of the situation in the same article (1989) when asked what impact would immediately improved vocational training have on the automotive industry.

> What is required to get the qualifier, that is, improved vocational training, is that there must be improvements which include greater emphasis on reading, on math, on science, on communication skills and lastly an improvement to include the greater emphasis on looking at the development of technical skills.11

Groves continues with a discussion of the importance of these "building blocks" to vocational success in the automotive industry. He claims to understand the "magnitude" of the problem to get all students to become competent in basic skills and says that his company, like that of Chrysler, is working to improve education in the United States.

The editor of the second Industrial Education (1989) magazine writes in his article:

> The automotive technician of the future ("mechanic" is an antiquated term now), will need the basic reading/writing/math skills--skills that can't be taken for granted any longer. They are crucial to understanding and operating successfully in this new age of automechanics.[12]

Finally, the perception of what basic skills are needed to operate successfully in the automotive industry can be seen from what those who own and operate the various facets of the industry think. This study done by the Technical Division of John C. Calhoun Community College (1989) surveyed thirty-five area businesses in Decatur, Alabama to determine which core skills were needed in the automotive industry.

> All listening, oral communication, and reading skills listed on the survey were considered necessary or highly desirable. Mathematic competencies needed were for basic computation skills, measurement and conversion skills, and problem-solving skills related to ratio and proportions and the use of formulas.[13]

Summary

The literature cited here substantiates the fact that a desirable quality in basic skills held by today's vocational students, in general, is lacking. Certainly, the literature related specifically to the automotive industry is clear. Several top people in the industry claim better education in basics is needed. Others in the industry, and those who reported the studies herein, relate the necessity of basic skill competency to adequate performance in the field.

All of the literature, whether generally related to vocational education or narrowed specifically to automotive, mentions the necessity for reading and math skills. The automotive industry, it

claims, since 1980 has become exceedingly complex. The days when a mechanic or technician could learn on his own or from another backyard mechanic are history. The manuals have become more complex and require reading ability, word knowledge, comprehension, ability to follow directions, math computation, and problem solving skills. Even the tools, machinery, and diagnostic equipment require skills related to reading and mathematics.

Further, the literature warns us that our industrial economic position in the world could very well be at stake unless we better educate our youth in the basic skills. All three major car companies in the United States realize this and are working in conjunction with education to better improve our status.

The literature seems clear; there exists a correlation among basic skills, automotive class room performance, and success on the job as an automotive technician and in related areas.

CHAPTER III
Methodology

Research Approach and Design

This is a nonexperimental ex post facto comparative study based on three factors: (1) the grade level indicated by standardized tests in basic skills--reading and math--attained by students enrolled in the automechanics classes at the Jackson Area Career Center, (2) the grades attained in the automechanics classes by these same students, and, (3) their occupational satisfaction in automechanics and/or related areas. The study will attempt to determine if correlations exist between basic skill grade levels as indicated by standardized tests to grades in automechanics and employee/employer satisfaction in automechanics or related occupational areas. Correlations will be measured by scattergrams and the Pearson *r* correlation coefficient.

The design of this study uses grade levels indicated in standard basic skills testing as the independent variable, and the dependent variables are the grades students achieve in the auto mechanics classes, and their successful job placement and performance.

Data Collection and Selected Subjects

Standardized testing of students entering the Jackson Area Career Center is done by qualified personnel upon entry to vocational classes at the Jackson Area Career Center. The two tests used to determine grade levels in basic skills are the *Shaw-Hiehle Computation* test for mathematics and the *Reading Progress Scale* for reading.

These test scores for grade level determination in basic skills are needed to compare grade levels to success in automechanics classes, and occupations. The test scores are obtained directly from the test administrator and are open for inspection to all teachers who supervise a particular student.

The grades of all subjects in automechanics classes are gathered from the automechanics teachers so they could be correlated to grade levels in basic skills and to job success. Also, the occupational related information from *Vocational Education Data Systems (VEDS)* was gathered and correlated. All information is included in "DATA" charts in *Appendix C.*

The subjects are all of the students enrolled in automechanics classes at the Jackson Area Career Center over the past five years who took the standardized basics skills tests previously mentioned and completed the information questionnaire from *VEDS.*

These subjects are a representative sample of similar students in the State of Michigan, and are a mix of urban, suburban, and rural students. They are also a representative mix of races, socioeconomic backgrounds, and status. Names are not used; students are designated by numbers.

This is a two year program, and if a student took two tests--one each year--the highest test scores are used. The scattergram and the Pearson *r* correlation coefficient is used to determine the relationships between the independent and dependent variables. The probability score is also given as an additional measurement.

Instrumentation

The tests used to determine grade level of basic skills are the *Reading Progress Scale* for reading and the *Shaw-Hiehle Computation* test for mathematics. A third instrument, the *Vocational Education Data System (VEDS)* report, is used to determine occupational placement and job success as reported by the student.

Three persons reviewed the *Reading Progress Scale* in the Mental Measurements Yearbook and all tended to indict the test as a poor instrument. The test has two forms, each of which consists of four paragraphs, printed on a single sheet. For each form, the first paragraph is proposed as comparable in reading difficulty to material used in grades 1-3: the second paragraph supposedly corresponds in difficulty to material in grades 4-6: the third paragraph to grades 9-10: and the fourth paragraph, grades 10-12.

Blaine R. Worthen, Director of Evaluation and Research of the Northwest Regional Educational Laboratory in Portland, Oregon (1972, p. 739) cites the test for a lack of rationale for the use of civics for the content of one form, and for geography for the other. Further, Worthen claims the validity data on the scale are limited and exist only for grades 3 through 6. He continues (p. 740) his indictment suggesting there are no aids provided to judge the reliability of the scores or how to use the scores diagnostically.

Shirley Feldmann's review in the Mental Measurements Yearbook (1972, p. 741) of the above test tends to agree with Worthen in all respects except she reports the test to be complex in format and procedure while Worthen disagrees and claims it to be "uncomplicated and simple to administer."

The third reviewer, Larry A. Harris, Professor of Education at Polytechnic Institute and State University in Blackburg, Virginia issues like statements about reliability and validity. He also dates the test as a 1938 product, and claims that only an extraordinary reading test that old could have little value today.

It, therefore, seems that the reading test administered by the Jackson Area Career Center may have some flaws; however, it is the only scale available for measurement of grade level in reading for the subjects in this study, and there is no alternative but to use it at this time.

After a search of the Mental Measurements Yearbook,the Tests in Print Index, and the test manual itself revealed no informational assessment found on the *Shaw-Hiehle Computation* test.

Procedures

1. An examination of the reading and mathematics grade levels of 150 students, approximately 30 per year, over a five year period was done. These were all students who completed all three of the following forms.
   a. The *Vocational Education Data Systems (VEDS)* form.
   b. The *Reading Progress Scale* test.
   c. The *Shaw-Hiehle Computation* test.
2. An examination of the automechanics course success, as determined by instructor grades, of the same 150 students was done.
3. An examination of the occupational success, as reported by *VEDS*, of the same 150 students was done.
4. All data was analyzed to determine appropriate correlations.

CHAPTER IV
Research Findings

Introduction

This study measures the correlation coefficient between math and reading levels measured by standardized tests, and success or failure in automechanics class and employee/employer job satisfaction determined by the employee.

Analysis Procedures

The grade levels in math and reading are measured by the *Shaw-Hiele Computation Test* and the *Reading Progress Scale* respectively. Grades in automechanics are derived from record books, and document only those students who completed the standardized math and reading test and the *VEDS* questionnaire.

The scattergram is used to give a picture of the correlation between the math and reading grade levels to the automechanics grade and the degree of employee/employer job satisfaction. The plottings are measured from 1-12 (1 equals a first grade grade level with 12 equal to a 12th grade level) for the independent variables of math and reading level and from 0-11 (0 equals a grade of "E" and 11 equals a grade of "A") for the auto grade. Plottings in the scattergrams reveal both the *direction* and the *strength* of the relationships. The conventional arrangement of the independent variable running horizontally and the dependent variable running vertically is used.

Direction refers to whether the relationship is positive or negative. If the dots form a pattern going from lower left to upper right and the

low scores on one variable correspond with low score on the other variable, and the high scores on one variable correspond with high scores on the other variable, the association is said to be positive. These dots can also show a negative correlation by a formation of a band of dots running from lower right to upper left.

The *strength* of a relationship in the scattergrams is measured by a narrow or wide spread band of dots. If the dots form a narrow band, the correlation is said to be strong. If the dots are widely scattered, there is a weak or no correlation. The conventional arrangement of the independent variable running vertically and the dependent variable running horizontally is used.

Next, in addition to the scattergram, the Pearson *r* is calculated to measure the percentage of correlation coefficient between the independent and dependent variables with (+ 1.0) being a perfect positive correlation and a (- 1.0) being a perfect negative correlation. It is expected to analyze the results of the picture in the scattergram by giving a correlation score.

Finally, the mean grade level of the basic skills is compared to the auto class grades for all students (**All**), non job related students (**Non**), and job related students (**Job**). The mean should reveal a relationship between the basic skills and auto grades for three classifications of students in automechanics.

The job satisfaction is measured on a continuum of 1-5 with one being very dissatisfied to 5 being very satisfied.

1	2	3	4	5
VERY DISSATISFIED	SOMEWHAT DISSATISFIED	SOMEWHAT SATISFIED	SATISFIED	VERY SATISFIED

Only the mean grade levels of the basic skills is reported and compared to the mean job satisfaction level.

All data was fed into a Macintosh computer and arrived at through a program published by Systat, Inc., 1989, of Evanston, Illinois.

Organization

The correlation between math and reading grade levels to auto grades is done independently for each year, 1985 through 1989. Then, the correlation between the grade levels of these two basic skills is drawn, independently, to auto grades for the combined total of the five years studied.

The next comparison is between the mean grade levels in basic skills and the mean auto class grades for all students, non-job related students, and job related students.

In the area of job satisfaction, it is noted from a cursory perusal of the "Data" charts there are 46 students who went on to work in automechanics or a related occupation. The job satisfaction level appears to be very high except in a couple notable cases, and there is little variation for each year. Therefore, because of the small number of subjects and the slight deviation of job satisfaction from year to year, only the correlation for all five years is drawn.

Findings for Question 1

The first question is, "Is there any correlation between student grade levels in mathematics as measured by a standardized test and success or failure in automechanics class?"

As indicated in the organization stated above we will first discuss the year 1985, then move through all the years and finally draw the mean for the combined five year period.

The scattergram (see page 24, Figure 1) for 1985 reveals a moderately weak correlation between math grade level and grades in automechanics class. There is little direction and even less strength to the plottings in the scattergram. This is supported by the Pearson *r* correlation of (+0.5) which is a moderately weak rating.

For the year 1986, the scattergram (see page 25, Figure 2) shows a rather weak correlation between math grade levels and and auto grades. The plots are randomly spread with no direction or strength shown. The Pearson *r* correlation tends to back that finding with a (+0.2) which is a very weak correlation with no significance.

The year 1987 has a strong correlation of math grade levels to auto grades. The scattergram (page 26, Figure 3) indicates those strong in math tend to get the highest grades in auto class. The scattergram reveals both direction and strength. The correlation of (+0.7) calculated by Pearson *r* is a significant positive correlation.

1988 is very similar to 1985 in the scattergram (see page 27, Figure 4). It shows a picture of a moderately weak plotting in both strength and direction. Again, the scattergram is supported by the Pearson *r* correlation of (+0.5).

Finally, the year 1989 returns with a strong scattergram relationship (see page 28, Figure 5) supported by a strong positive Pearson *r* correlation of (+0.7).

The mean correlation for the combined five years is a rather moderately weak correlation of (+0.52), indicating there is

approximately a 30 percent chance math grade level scores are unrelated to good grades in automechanics classes.

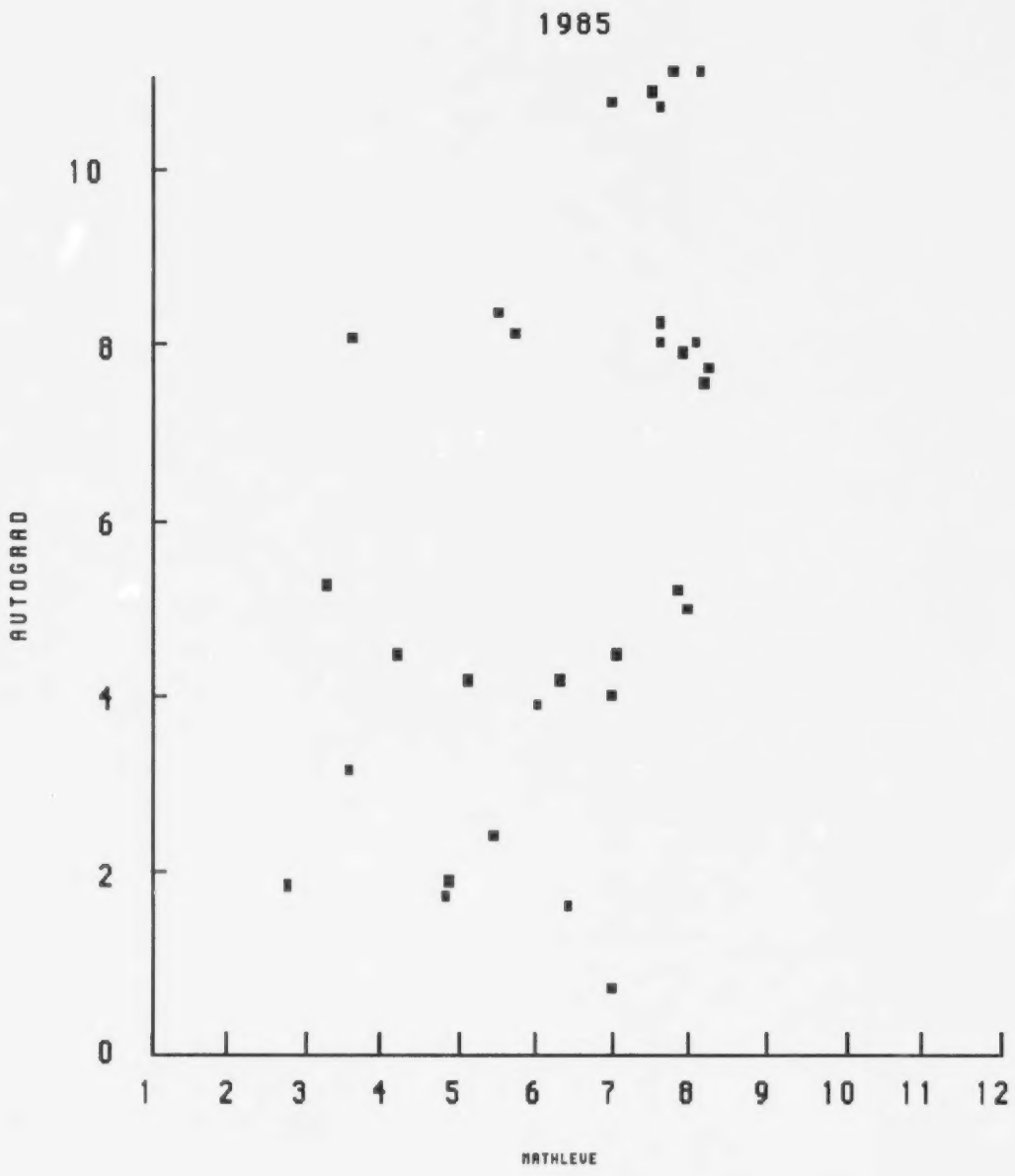

Figure 1. Pearson *r* Correlation = (+0.5) Paired Samples of 31 Cases

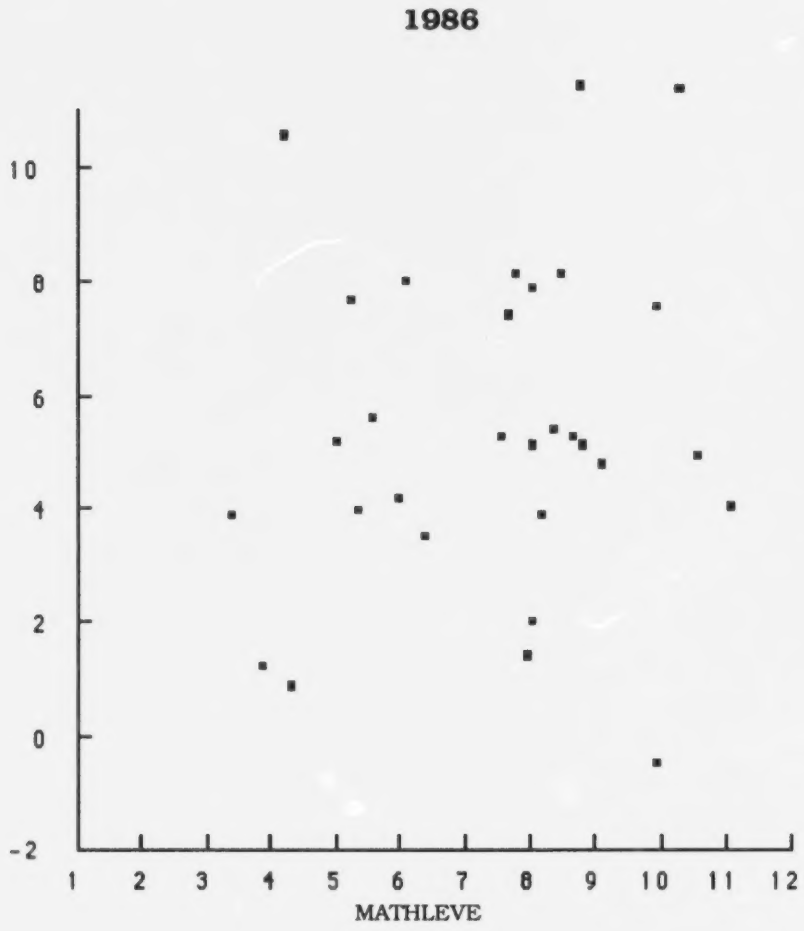

Figure 2. Pearson *r* Correlation = (+0.2) Paired Samples of 30 Cases

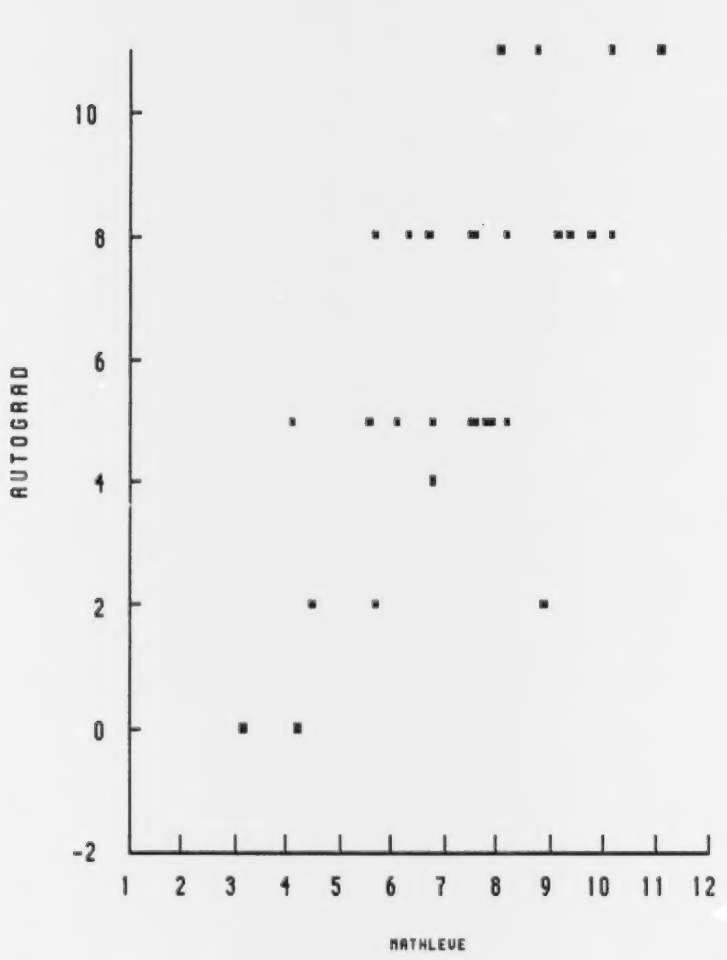

Figure 3. Pearson*r* Correlation = (+0.7) Paired Samples of 31 Cases

*SOME DOTS ABOVE ARE OVERLAPPED BY OTHERS BECAUSE THE DATA IS IDENTICAL.

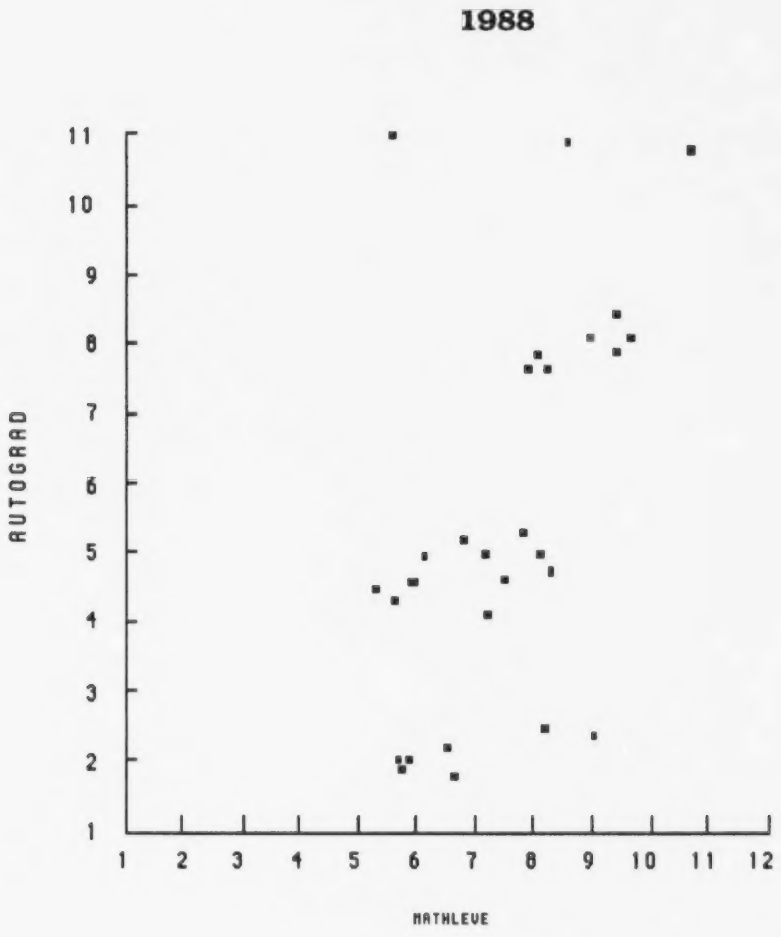

Figure 4. Pearson *r* Correlation = (+0.5) Paired Samples of 29 Cases

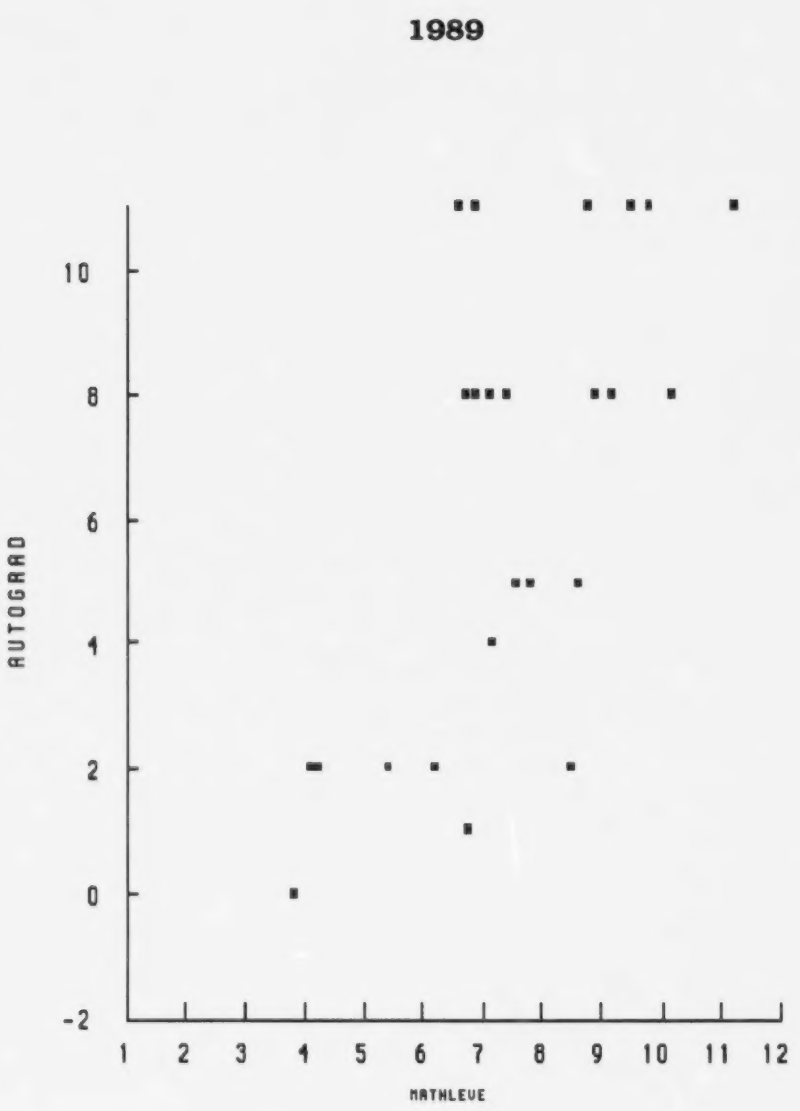

Figure 5. Pearson *r* Correlation = (+0.7) Paired Samples of 29 Cases

*SOME OF THE DOTS ABOVE ARE OVERLAPPED BY OTHERS BECAUSE THE DATA IS IDENTICAL.

Findings for Question 2

The second question is, "Is there any correlation between student grade levels in reading as measured by a standardized test and success or failure in automechanics class?"

Again, the organization will be to plot and correlate each year separately and then calculate a mean combined correlation for all five years.

The first scattergram plotting reading grade levels to auto grades (page 31, Figure 6) for the year 1985 indicates a strong positive correlation in both direction and strength. Definitely, the higher the grade level students had in reading, the higher the auto grade they achieved. The Pearson *r* correlation of (+0.8) supports the strong trend in direction and strength given on the scattergram.

In the year 1986, the plots on the scattergram (page 32, Figure 7) are very random showing little direction or strength. The Pearson *r* correlation of (+0.4) between reading grade level and auto grades is also very weak.

!987 is practically a duplicate of 1986. The plottings on the scattergram (page 33, Figure 8) are randomly scattered and are supported by a weak Pearson *r* correlation of (+0.4).

A significant flip occurs again in 1988 when the scattergram (page 34, Figure 9) reveals both direction and strength. The Pearson r correlation agrees with a rating of (+0.7).

Finally, in the year 1989, there is positive direction and strength indicated on the scattergram (page 35, Figure 10). This year is comparable to the 1985 year which had a strong positive Pearson r correlation of (+0.8)

Overall, for the five combined years correlating reading grade levels to auto grades the mean correlation is (+0.62), which is a moderately positive correlation.

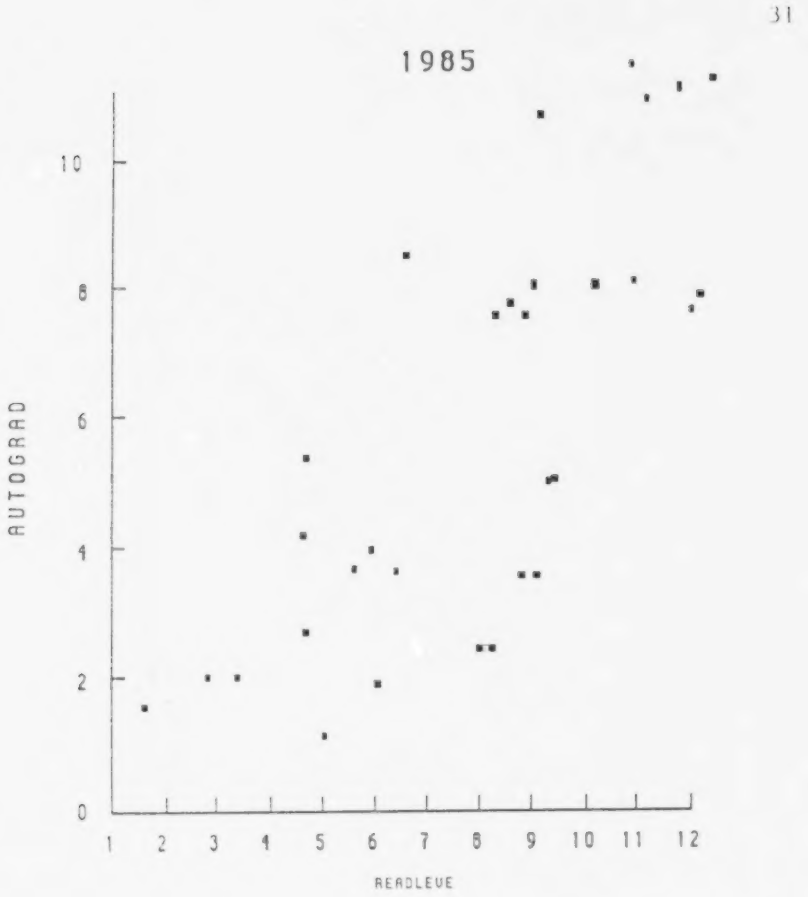

Figure 6. Pearson*r* Correlation = (+ 0.8) Paired Samples of 31 Cases

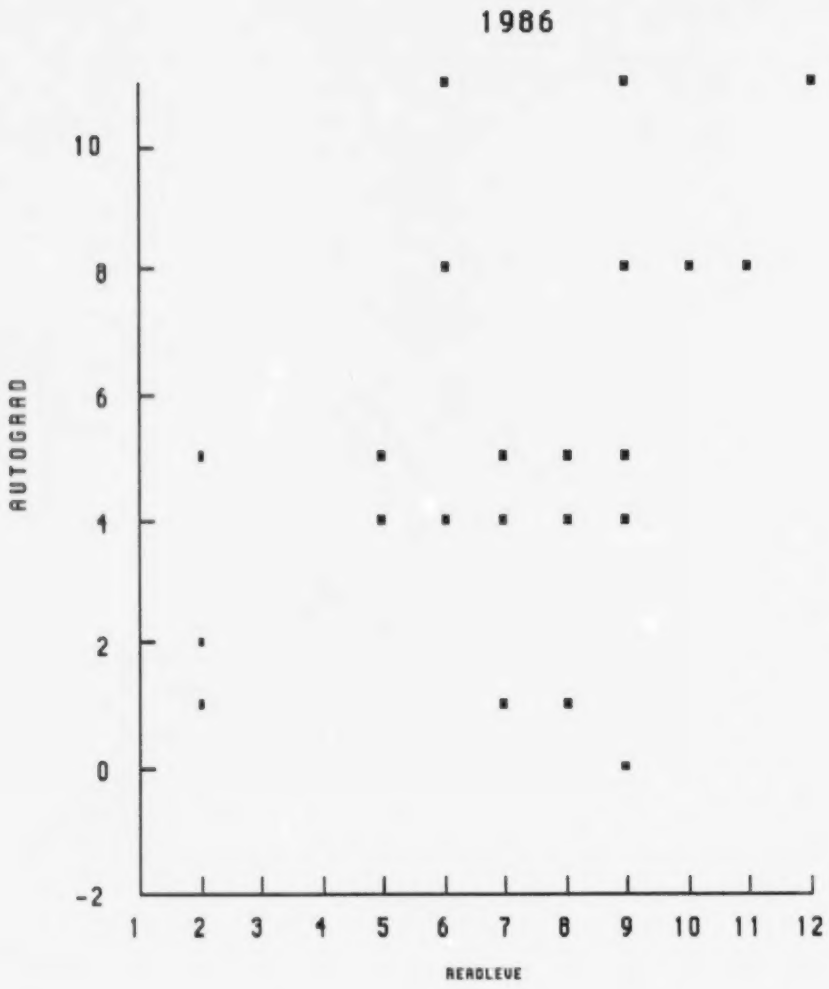

Figure 7. Pearson*r* Correlation = (+ 0.4) Paired Samples of 31 Cases

*SOME OF THE DOTS ABOVE ARE OVERLAPPED BY OTHERS BECAUSE THE DATA IS IDENTICAL.

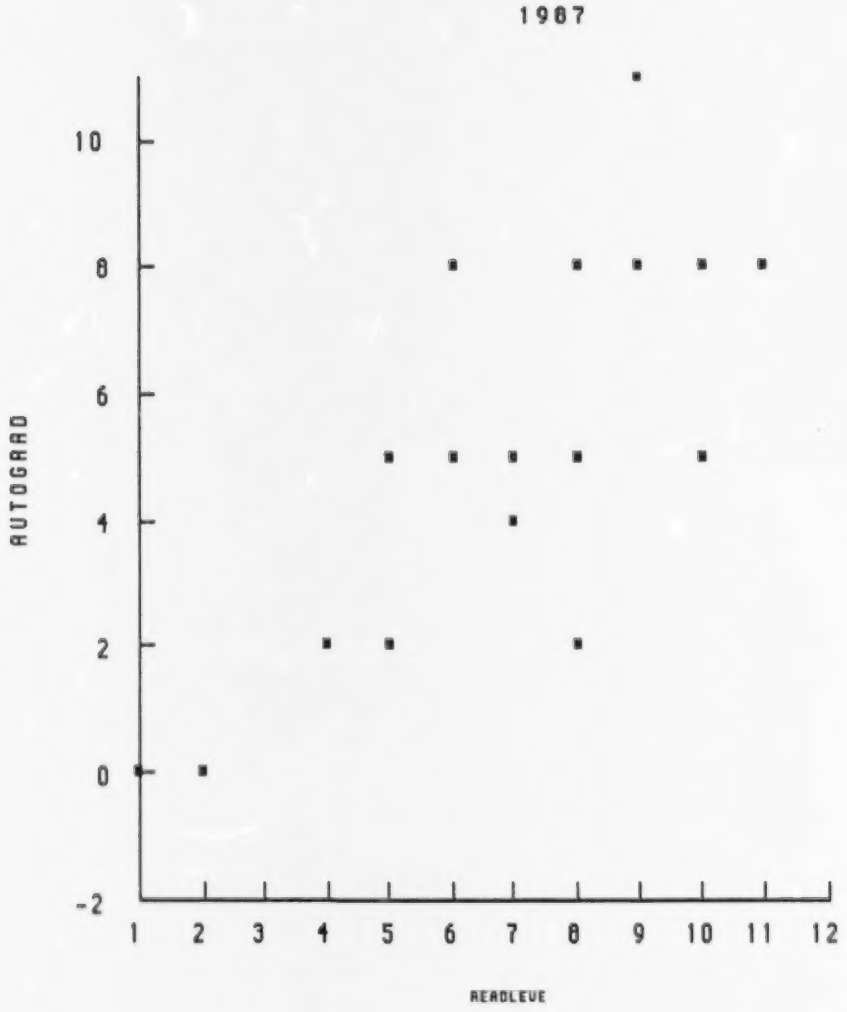

Figure 8. Pearson *r* Correlation = (+ 0.4) Paired Samples of 31 Cases

*SOME OF THE DOTS ABOVE ARE OVERLAPPED BY OTHERS BECAUSE THE DATA IS IDENTICAL.

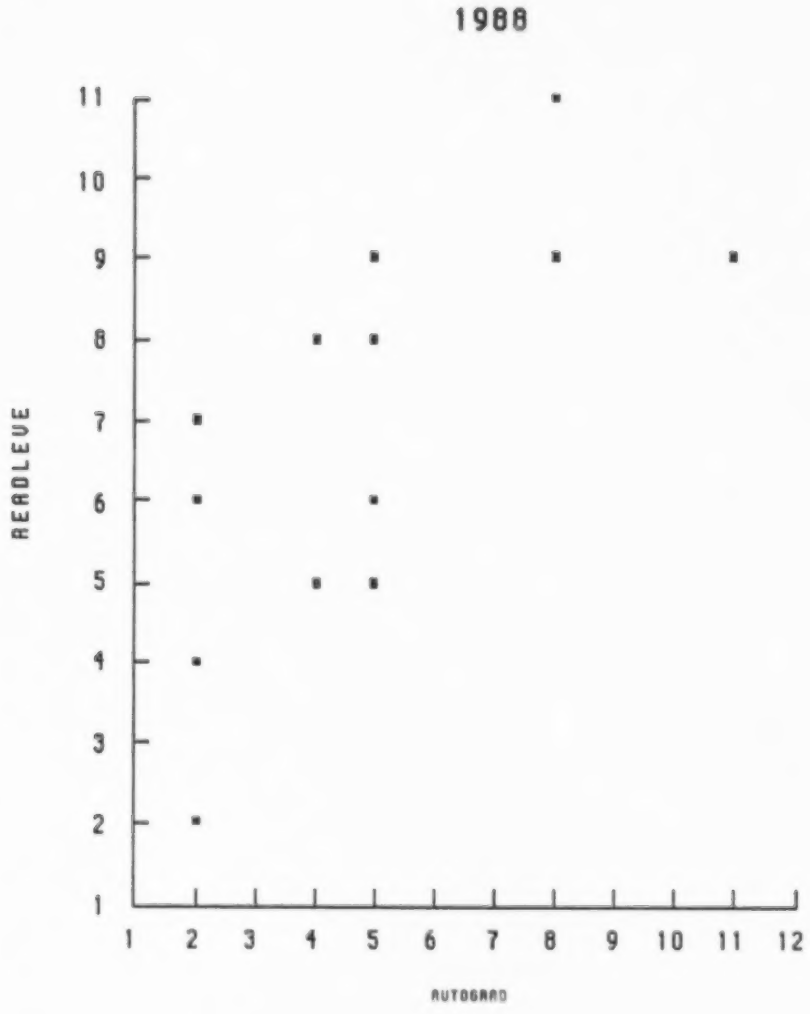

Figure 9. Pearson *r* Correlation = (+0.7) Paired Samples of 29 Cases

*SOME OF THE DOTS ABOVE ARE OVERLAPPED BY OTHERS BECAUSE THE DATA IS IDENTICAL.

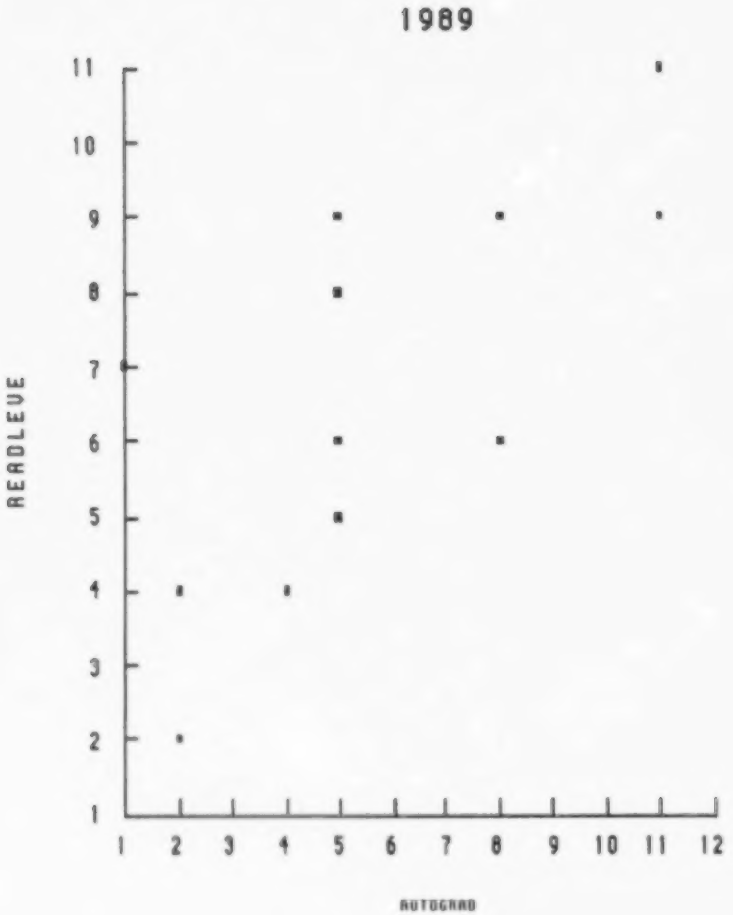

Figure 10. Pearson *r* Correlation = (+0.8) Paired Samples of 29 Cases

*SOME OF THE DOTS ABOVE ARE OVERLAPPED BY OTHERS BECAUSE THE DATA IS IDENTICAL.

Findings for Question 3

The third question is, "Is there any comparison between the mean grade levels of basic skills and the automotive mean grades achieved by all students, non-job related students, and job related students?

An examination of the following Table 1 indicates those students who enter job related occupations exceed those students in math grade levels and reading grade levels by, in most cases, at least one full grade. It also reveals their grade in auto class to be approximately on full grade higher.

Table 1. Mean Math Levels, Reading Levels, and Auto Grades for all Students Studied (**ALL**), Non Related Job Students (**NON**), and Job Related Students (**JOB**)

GRADE AND GRADE LEVEL	AUTO GRADE **ALL**	MATH LEVEL **ALL**	READ LEVEL **ALL**	AUTO GRADE **NON**	MATH LEVEL **NON**	READ LEVEL **NON**	AUTO GRADE **JOB**	MATH LEVEL **JOB**	READ LEVEL **JOB**
12									
11									
9									
8							B	8.1	8.9
7		7.0	7.3						
6					6.1				
5	C					5.4			
4				C-					
3									
2									
1									
O									

Findings for Question 4

The fourth question is, "Is there any correlation between student grade level in mathematics as measure by a standardized test and job satisfaction as measured by the employee on the part of the employee and employer?"

As stated previously, "job satisfaction" is difficult to define because of the many variables. Because of this factor, the obvious high level of reported job satisfaction, and the few students who enter automechanics and/or related fields each year, job satisfaction will be combined for all five years and compared to the mean math grade levels and the mean auto grade.

There are a total of 46 students who accepted jobs in auto mechanics or related areas. Their mean math grade level was 8.1, and the job satisfaction level for these students is a mean of 4.47 (page 36, Table 1).

Findings for Question Five

The fifth question is, "Is there any correlation between student grade level in reading as measured by a standardized test and job satisfaction as measured by the employee on the part of the employee and employer?"

Again because of the factors mentioned above, the reading grade level and the job satisfaction level will be computed by the mean. In reading grade level the students achieved a mean of 8.9, or almost a 9th grade reading level while achieving a mean job satisfaction level of 4.47 (page 36, Table 1).

Summary of Major Findings

This section will first discuss the math/auto grade then the reading/auto grade scattergrams in conjunction with the Pearson *r* correlation coefficient. Second, the means in Table 1 on page 36 will be discussed. Finally, the job satisfaction results will be discussed as a whole.

There seems to be a wide variance in the math/auto grade scattergram pictures, supported by the Pearson *r* correlation coefficient. The scattergram showing the least correlation is in the year 1986 (page 33, Figure 6). For this year, the correlation measured by the Pearson *r* is a very weak (+0.2). This very weak correlation, however, is the only one below (+0.5) of which there are two. Then there are two moderately positive scattergram pictures with a correlation of (+0.7). The mean correlation for the combined five years of (+0.52) is severely affected by the low correlation year of (+0.2).

Overall, judging from the scattergrams and the correlation coefficient there appears to be a moderately weak positive relationship between students' grade levels in math and the grades they received in auto class. This research indicates there is, at least, some significance to the chance that students who are better achievers in math will be the better achievers in obtaining good grades in auto class.

In the comparison of reading grade levels to math scores and auto grades, the results are even more positive. It is noted the lowest correlations occur in the years 1986 and 1987 with a random scattergram picture, and a Pearson *r* correlation coefficient of (+0.4)

which is significantly weak; however, the other three years (1985 1988 and 1989), show positive correlations of (+0.8), (+0.7), and (0.8).

Even with the two noted weak correlations, the mean for the combined five years is a positive correlation of (+0.62) which indicates there is a positive chance those students who have achieved high grade levels in reading will achieve high grades in auto classes.

In summarizing both math and reading grade levels as shown by the scattergrams and the Pearson *r* correlation coefficient, reading levels show a more positive relationship to auto grades than math levels. Though some of the years show very weak correlations, others show rather positive correlations. Some explanations for this deviation will be discussed in the part of this paper titled "Explanation of Findings."

The above results are furthered by a comparison of the mean math/reading levels to mean auto class grades. From the chart on page 33, it is noted that those students entering automechanics jobs or closely related jobs (**JOB**) have the highest math grade levels, the highest reading grade levels, and the highest auto grades when compared to all auto students studied (**ALL**), and to those (**NON**) who do not enter automechanics occupations or related jobs. Their math grade levels exceed **ALL** by at least one full grade and the **NON** students by two grades. The reading levels exceed **ALL** by eight tenths of a grade and **Non** by three and one half grade levels. The auto grade is better than the others by one full grade.

This mean average comparison seems to be moderately significant for the job related students. They are the only students who are achieving above average grades in automechanics classes.

As previously mentioned, there is a high mean level, 4.7 on a scale of 5, of job satisfaction. When breaking down job satisfaction rankings there were 3 students with a rank of 1--very dissatisfied--in 1986 and 1987, one student with a rank of 2--somewhat dissatisfied--in 1985, one student with a rank of 3--somewhat satisfied--in 1987, 13 students with a rank of 4--satisfied--, and 29 students with a rank of 5 who were very satisfied.

It appears then, those students who enter automechanics or job related occupations have the highest grade levels in basic skills and are very satisfied with their jobs.

Explanation of Findings

Overall, there appears to be some link to grade levels in basic skills to auto grades and job satisfaction. Math levels appear to be less positively related to auto grade and job satisfaction while reading is more positively significant. In auto class, there is more emphasis on reading skills than math skills. The student is often required to read and comprehend chapters in manuals which have no computation in them, and usually when computation is required the specific computation task i.e., fractions, decimals, division, is covered by the instructor. Both skills, though, are important in passing automechanics at the Jackson Area Career Center.

This significance in the correlation for both math and reading is due to the complexity of the material in the auto manuals of today.

These manuals are much more complex than 5 to 10 years ago requiring reading comprehension and math computation skills to approximately an eighth grade level. This is substantiated by the research that indicates students below the eighth grade level in both basic skills do not achieve grades above a C.

In the year 1986, there is little correlation (+0.2) to math and it piqued an interest to find out why. It was revealed the math consultant adapted the *Shaw-Hiehle Computation Test* to "...adjust it to changing technical criteria." Through further discussion with the examiner it was not clear exactly what that meant.

The students who are most successful in automechanics and who have the high job satisfaction rankings, are those with the highest achievement in grade levels. This could be explained by the adage "success breeds success;" they achieved best in auto classes, and therefore chose that area in which to work.

Link to Literature Review

The literature reviewed herein, draws the firm conclusion that today's auto technicians must have a high degree of literacy in basic skills. It states unequivocally, "The days of the backyard mechanic are gone." This, of course, is based on the emerging sophistication of the modern automobile.

Today's automobiles have; computers which control many functions; the relatively simple carburetor is replaced by complex injection systems; drivetrain ratios are critical; braking systems go beyond the basic mechanical systems; the degree of exhaust emission is critical to performance in meeting new governmental standards;

tool design and sophistication extends far beyond the end wrench; special computerized diagnostic machines must be set to read out the data with a variety of automobiles and trucks; etc., etc.

The literature reviewed recognizes this new sophistication, and suggests we need better prepared students and better training methods.

CHAPTER V
Summary and Discussion

Problem Restatement

This study is made to determine the correlation between grade levels in basic skills as measured by standardized tests to grades in auto mechanics and job satisfaction.

Listing of Major Findings

1. Student math grade levels determined by the *Shaw-Hiehle Computation Test* show a moderately weak positive correlation to grades achieved in auto classes and to job satisfaction.
2. Student reading grade levels determined by the *Reading Progress Scale* show a moderately positive correlation to grades achieved in auto classes and to job satisfaction.
3. Student means in math and reading grade levels when compared to auto class grades appear to be significant for those entering automechanics or related occupations. The students entering automechanics or related occupations have the highest math and reading levels, and the highest auto class grades when compared to all auto class students and to auto class students not entering the occupations of automechanics.

Methodological Limitations

The first methodological limitation could be the *Reading Progress Scale* and the *Shaw-Hiehle Computation Test.* The reading test received less than rave reviews in Mental Measurements Yearbook and was considerably outdated. This might have contributed to either more positive or less positive correlations.

A second limitation could be that all students were not studied. Slightly more than one half of all students could not be studied because all had not taken the three tests--*VEDS, Reading Progress Scale, Shaw-Hiehle Computation*--required to complete the research.

A third limitation is the job satisfaction method of measurement. It seems logical in most cases if the employee is satisfied with the job the employer would be satisfied with the employee but, of course, this may not always be the case. Also, related to the job satisfaction measurement are many variables relating to job satisfaction. It is very possible the employee is not satisfied with the job per se i.e., the task, but it could be the pay, his peers, his boss, or many other factors. Generally, though, what should be noted is the employee or employer is generally satisfied or dissatisfied with the job and the advantages or disadvantages outweigh.

Suggested Applications

The information in this study should be used to better facilitate the learning of students in automechanics class and, thus, better prepare them for an occupation in automechanics or a related field.
Some suggestions are made below to achieve this goal.

If it is true there is a correlation of math and reading skills to success in auto classes and job satisfaction, then the sharing this information with Career Center administrators and counselors, high school administrators and counselors, and other pertinent personnel responsible for the placement of automechanics students in the Jackson Area Career Center is crucial.

The area school administrators, counselors, and teachers could initiate special prerequisite classes into the curriculum to introduce students to the "language" in both math and reading to better prepare them for success in technical classes and jobs. These classes could also serve as a guidance procedure either initiated by the student or instructor, and thereby could steer the student into a field of study where greater success and satisfaction could be obtained.

In the last year, eight area schools adopted programs similar to the idea above. The classes called "Tech Prep" are designed to meet the needs of high technology in secondary vocational education. Specifically, they have three goals:

1. to reinforce problem solving by a team approach,
2. to understand today's technological systems and,
3. to use concepts in technology in all fields and/or areas of interest.

Although these programs do not concentrate entirely on automechanics, they do teach some basic skills used in auto technology. This program, developed by The Michigan Industrial Technology Society, could be expanded to all area schools feeding the Career Center.

Another application would be to expand the entire program at the Career Center whereby the automechanics instructors could teach a one semester class introducing the students to the basic skills specifically related to auto classes. James Dunn from the State University of New York proposed some "Sample Lesson Ideas" which could be expanded and adapted to the curriculums of specific auto career centers.[14] One of his "Lesson Ideas Focusing on Reading Skills" is included in *Appendix D.*

It seems the automechanics instructors would be best suited for this class. Logically, they are the experts on what is taught in the class and should best know the prerequisites in math and reading. Better preparation in these areas would permit greater concentration on the manipulative facets of automechanics and result in greater student success.

Also, to measure student competencies for entering the the automotive program, special tests and assessments could be given. These would serve as a guide to help auto instructors determine what related basic skills should be taught either in the prerequisite classes or the regular automechanics classes.

These tests should measure a basic reading and math grade level, a basic language revealing some fundamental understanding of automobile parts and functions, and a fundamental knowledge of some mathematical computations used in automobile repair.

Recommendations for Future Study

There appear to be a number of other possible studies further the understand the stated questions in this study.

First, a study of other academic subjects related to success in automechanics could be undertaken. There may be other classes which bear heavily on success in automechanics yet uncovered.

Second, a study of the correlation between automechanics grades and job satisfaction could go further. A better definition, understood by the employee and the researcher, should be constructed. Even a method to poll the employer could be devised.

Third, a study concerning why more students do not go into auto mechanics occupations after graduating successfully from the course might reveal information to revise the total program for the better. Although 46 students entered automechanics or related jobs is approximately one third of the 150 studied, this is not a true picture of the total. Obviously, many students who enter auto mechanics drop out through various factors of attrition and can't be counted, so the 46 when compared to the 150 is out of proportion. It is closer to 46 out of a total of 800 over a five year period.

Fourth, a compilation of opinions from those who have graduated from automechanics as to changes in the curriculum to better facilitate adaptation to the classes in automechanics and to the job of auto technician.

Finally, this study could be done again using different instruments from the *Reading Progress Scale* and the *Shaw-Hiehle Computation Test* to determine grade levels in reading and math.

APPENDIX A

STUDENT QUESTIONNAIRE
PLEASE CHECK THE APPROPRIATE BLANKS

1. WHOSE IDEA WAS IT FOR YOU TO ENROLL IN AUTOMECHANICS?

SELF__25% COUNSELLOR_37% TEACHER_15% PARENTS__19%
IF OTHER, TELL WHOM___4%

2. WOULD YOU RANK AUTOMECHANICS CLASS:

EASIER THAN ENGLISH_10% HARDER THAN ENGLISH_46% ABOUT THE SAME AS ENGLISH_44%

EASIER THEN MATH__46% HARDER THAN MATH__12% ABOUT THE SAME AS MATH__42%

EASIER THAN READING_8% HARDER THAN READING__29% ABOUT THE SAME AS READING_63%

3. DO YOU THINK YOUR SUCCESS IN AUTOMECHNICS IS HELPED:

A LOT BY GOOD READING SKILLS_93% VERY LITTLE BY GOOD READING SKILLS_7%

A LOT BY GOOD MATH SKILLS_88% VERY LITTLE BY GOOD MATH SKILLS_12%

4. WHICH REGULAR HIGH SCHOOL CLASSES HELP YOU MOST IN AUTO MECHANICS?

RANK THE CLASSES THAT HELP YOU MOST: *The Mean Rank is Given

1= VERY IMPORTANT
2= SOMEWHAT IMPORTANT
3= DON'T KNOW
4= LITTLE IMPORTANCE
5= NO IMPORTANCE

4__SPEECH 2__PHYSICAL EDUCATION
1__MATH 4__HISTORY
2__ENGLISH 1__GOVERNMENT
5__BIOLOGY 5__ART
1__READING/COMPREHENSION

5. DO YOU THINK AUTOMECHANICS IS AS RESPECTED AS OTHER COURSES OF STUDY LIKE COLLEGE PREPARATION COURSES?

YES_34% NO__66%

6. DO YOU THINK COLLEGE PREPARATION STUDENTS MAKE FUN OF STUDENTS BECAUSE THEY ARE ENROLLED IN AUTOMECHANICS?

YES__26% NO__74%

7. DO YOU PLAN TO ENTER AN AUTOMECHANICS RELATED OCCUPATION?

YES___12% NO__88% .

***Percentages are given over the past two years.**

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APPENDIX B

CAREER CENTER TEXT BOOK: AUTO SERVICE AND REPAIR, (1986), MARTIN STOCKEL.

To check the contact pattern, (preload and backlash must be correct) cover all the ring gear teeth with a light coating of red lead and oil. Mix powdered red lead with engine oil to

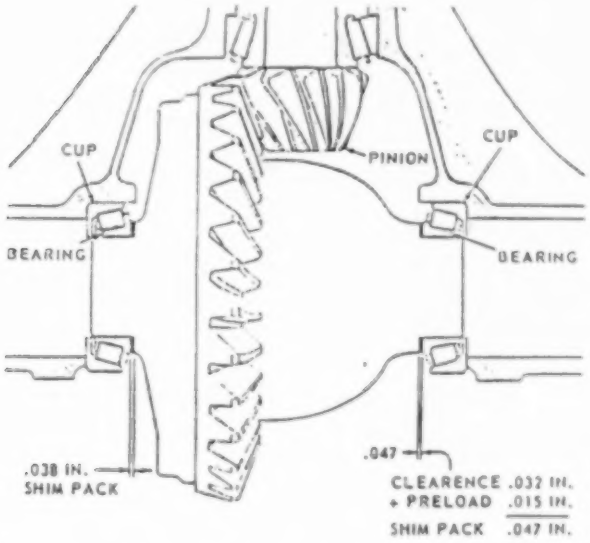


Fig. 28-63. This assembly places shims between the carrier and bearing cones. (Lincoln)

produce a paste. Apply to the teeth with a fairly stiff paint brush. Some new gear sets come with a special compound for coating the teeth. See Fig. 28-64.

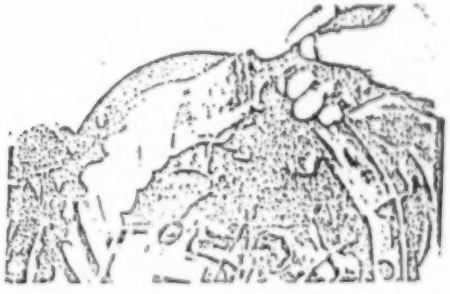


Fig. 28-64. Painting ring gear with red lead and oil mixture.

Using a wrench, turn the pinion shaft in the normal forward drive direction while creating a drag on the ring gear. The mechanic, in Fig. 28-65, is using a brass drift to bind the ring gear. Continue turning the pinion until the ring gear has made one full turn. This will produce a DRIVE (pinion driving ring) contact pattern,

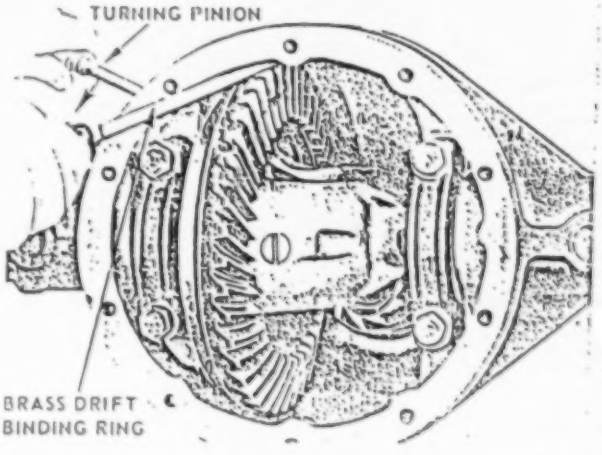


Fig. 28-65. Cranking pinion while binding ring gear to produce a drive pattern.

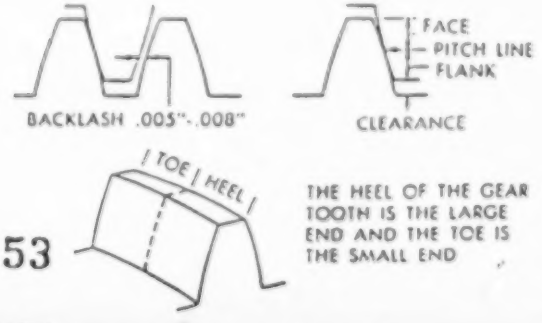
Turn the pinion in the opposite direction, while binding the ring, to produce a COAST (ring drives pinion) pattern.

There is no exact pattern that must be formed, in that the pattern shape varies depending upon gear set design, wear, load, etc.

In general however, the pattern (contact area) should be even around the ring. Uneveness indicates excessive ring runout.

The DRIVE pattern should be centrally located between the top and bottom of the tooth. It can be somewhat closer to the toe, in that under increased loading the pattern spreads out and tends to move towards the heel of the tooth. When the point of heavy loading is reached (pulling hills or rapid acceleration), the pattern may extend almost the full distance from toe to heel. The DRIVE SIDE of a ring gear tooth is the CONVEX side.

The COAST side of a ring gear tooth is the CONCAVE side. Note the gear tooth nomenclature in Fig. 28-66.



APPENDIX B CONTINUED

CAREER CENTER TEXT BOOK: AUTO SERVICE AND REPAIR, (1986), MARTIN STOCKEL

Differential, Axle, Seal and Housing Service

The COAST pattern should also be centralized between top and bottom of the tooth. It may be a little longer and closer to the toe.

Examine the pattern closely for the presence of thin, hard pressure lines that indicate an area of narrow contact that will produce unusually high localized pressure. Such lines should not be present.

SPECIAL TRACTION DIFFERENTIAL

The limited slip (also called Sure Grip, No-Spin, Anti-Spin, Positive Traction, etc.) type of traction differential, uses friction members (cone or disc clutch) so arranged that when one wheel attempts to spin, driving force will still be applied to the nonspinning wheel.

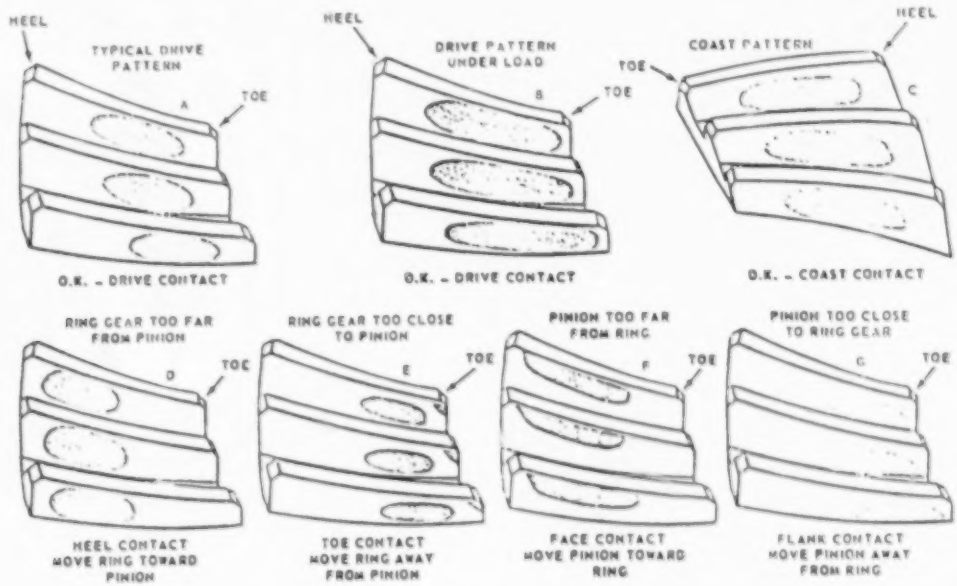


Fig. 28-67. Typical ring gear tooth contact patterns.

Typical ACCEPTABLE DRIVE and COAST patterns are pictured in A, B, and C, Fig. 28-67. UNACCEPTABLE patterns, D, E, F, and G, are also shown.

A HEEL contact pattern is caused by excessive backlash and is corrected by moving the ring towards the pinion, D. See Fig. 28-67. TOE contact indicates insufficient backlash. To correct, move the ring away from the pinion, E. FACE contact indicates the pinion is set too far from the ring and to correct, move the pinion TOWARD the ring, F. FLANK contact requires moving the pinion AWAY from the ring gear, G.

When moving either ring or pinion to correct the contact pattern, move in small amounts. Make certain that the bearings are properly preloaded, the cap fasteners fully torqued, and the backlash within specifications before rechecking pattern.

In the conventional, nontraction differential, when one wheel spins, no driving force is applied to the other.

A traction differential, using a clutch pack on either side of axle side gears, is pictured in Fig. 28-68.

In the Sure Grip design, Figs. 28-68 and 28-69, two pinion shafts are used. Note that the ends of the shafts are wedge shaped and that they operate in V shaped ramps.

When a driving force is applied to the ring gear, the pinion shafts slide up the V ramps and compress both clutch packs. This effectively provides a mechanical connection between both axles.

When rounding a corner, the outside axle turns faster than the inner axle. This causes the pinion shaft on the outer side to slide down its ramp. This releases the clutch pack on that side and allows normal differential action.

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APPENDIX B CONTINUED

MANUAL: CHILTON'S DOMESTIC TUNE-UP MANUAL, (1987), CHILTON BOOK CO.

SECTION 10 FUEL INJECTION

FORD THROTTLE BODY FUEL INJECTION

FORD ELECTRONIC FUEL INJECTION TROUBLESHOOTING

Symptom	Possible Problem Areas
Stalls at idle	1. Idle speed wrong 2. Throttle kicker not working
Hesitates on acceleration	1. Acceleration enrichment system defective 2. Fuel pump ballast bypass relay not working
Fuel pump noisy	1. Fuel pump ballast bypass relay not working
Engine won't start	1. Fuel pump power relay defective, no spark, EGR system defective, no or low fuel pressure 2. Crankshaft position sensor not seated, clearance wrong, defective 3. Pulse ring behind vibration damper misaligned, sensor tabs damaged 4. Power and ground wires open or shorted, poor electrical connections 5. Inertia switch tripped
Engine starts and stalls or runs rough	1. Fuel pump ballast wire defective 2. Manifold absolute pressure (MAP) sensor circuit not working 3. Low fuel pressure 4. EGR system problem 5. Microprocessor and calibration assembly faulty
Starts hard when cold	1. Cranking signal circuit faulty

①See Ford Electronic Engine Control (EEC) for adjustment procedures.

FORD EFI-EEC IV PORT FUEL INJECTION

General Information

The EFI-EEC IV System combines an electronic engine control module with a port fuel injection system to provide a more precise control over the air/fuel ratio, spark timing, deceleration fuel shut-off, EGR, curb and fast idle speed, evaporative emission control, and cold engine enrichment. The EFI-EEC IV system can be divided into three basic subsystems—Fuel, Air and Electronic Engine Control. This section will deal with the Fuel and Air systems only; for all service information on the Electronic Engine Control system, please see the "Engine Controls" Unit Repair section.

NOTE: For wiring diagrams and diagnosis charts on the EEC IV System, see the "Engine Controls" Unit Repair section.

EFI-EEC IV Fuel System

COMPONENTS AND OPERATION

The fuel subsystem includes a high pressure electric fuel pump, fuel charging manifold, pressure regulator, fuel filter and both solid and flexible fuel lines. The fuel charging manifold includes four electronically controlled fuel injectors, each mounted directly above an intake port in the lower intake manifold. All injectors are energized simultaneously and spray once every crankshaft revolution, delivering a predetermined quantity of fuel into the intake airstream.

The fuel pressure regulator maintains a constant pressure drop across the injector nozzles. The regulator is referenced to intake manifold vacuum and is connected parallel to the fuel injectors and positioned on the far end of the fuel rail. Any excess fuel supplied by the pump passes through the regulator and is returned to the fuel tank via a return line.

NOTE: The pressure regulator reduces fuel pressure to 39-40 psi under normal operating conditions. At idle or high manifold vacuum

The fuel pressure regulator is a diaphragm operated relief valve in which one side of the diaphragm senses fuel pressure and the other side senses manifold vacuum. Normal fuel pressure is established by a spring preload applied to the diaphragm. Control of the fuel system is maintained through the EEC power relay and the EEC IV control unit, although electrical power is routed through the fuel pump relay and an inertia switch. The fuel pump relay is normally located on a bracket somewhere above the Electronic Control Assembly (ECA) and the Inertia Switch is located in the left rear kick panel. The fuel pump is usually mounted on a bracket at the fuel tank.

The inertia switch opens the power circuit to the fuel pump in the event of a collision. Once tripped, the switch must be reset manually by pushing the reset button on the assembly. Check that the inertia switch is reset before diagnosing power supply problems.

FUEL INJECTORS

The fuel injectors used with the EFI-EEC IV system are electro-mechanical (solenoid) type designed to meter and atomize fuel delivered to the intake ports of the engine. The injectors are mounted in the lower intake manifold and positioned so that their spray nozzles direct the fuel charge in front of the intake valves. The injector body consists of a solenoid actuated pintle and needle valve assembly. The control unit sends an electrical impulse that activates the solenoid, causing the pintle to move inward off the seat and allow the fuel to flow. The amount of fuel delivered is controlled by the length of time the injector is energized since the fuel flow orifice is fixed and the fuel pressure drop across the injector tip is constant. Correct atomization is achieved by contouring the pintle at the point where the fuel enters the pintle chamber.

NOTE: Exercise care when handling fuel injectors during service. Be careful not to lose the pintle cap and replace damaged O-rin[illegible] to assure a tight seal. Never apply direct battery voltage to test an EFI fuel injector.

The injectors receive high pressure fuel from the fuel manifold (fuel rail) assembly. The complete assembly includes a single, pre-formed [illegible] with four injector connectors, mounting flange for the pressure

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APPENDIX B CONTINUED

MANUAL: CHILTON'S DOMESTIC TUNE-UP MANUAL, (1987), CHILTON BOOK CO.

regulator, mounting attachments to locate the manifold and provide the fuel injector retainers and Schraeder quick disconnect fitting used to perform fuel pressure tests.

NOTE: The fuel manifold is normally removed with fuel injectors and pressure regulator attached. Fuel injector electrical connectors are plastic and have locking tabs that must be released when disconnecting.

EFI-EEC IV Air System

COMPONENTS AND OPERATION

The EFI-EEC IV air subsystem components include the air cleaner assembly, air flow (vane) meter, throttle air bypass valve and air ducts that connect the air system to the throttle body assembly. The throttle body regulates the air flow to the engine through a single butterfly-type throttle plate controlled by conventional accelerator linkage. The throttle body has an idle adjustment screw (throttle air bypass valve) to set the throttle plate position, a PCV fresh air source upstream of the throttle plate, individual vacuum taps for PCV and control signals and a throttle position sensor that provides a voltage signal for the EEC IV control unit.

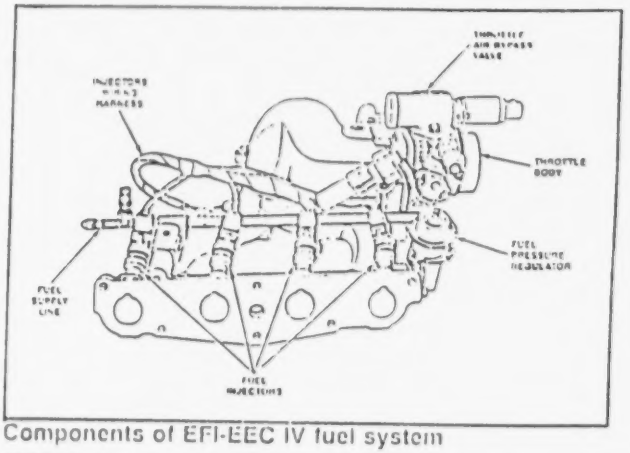
NOTE: For information on diagnosis and testing of all EFI-EEC IV system sensors, see the Engine Controls Unit Repair section.

The hot air intake system uses a thermostatic flap valve assembly whose components and operation are similar to previous hot air intake systems. Intake air volume and temperature are measured by the vane meter assembly which is mounted between the air cleaner and throttle body. The vane meter consists of two separate devices; the vane airflow sensor (VAF) uses a counterbalanced L-shaped flap vallve mounted on a pivot pin and connected to a variable resistor (potentiometer). The control unit measures the amount of deflection of the flap vane by measuring the voltage signal from the potentiometer mounted on top of the meter body; larger air volume moves the vane further and produces a higher voltage signal. The vane air temperature (VAT) sensor is mounted in the middle of the air stream just before the flap valve. Since the mass (weight) of a specific volume of air varies with pressure and temperature, the control unit uses the voltage signal from the air temperature sensor to compensate for these variables and provide a more exact measurement of actual air mass that is necessary to calculate the fuel required to obtain the optimum air/fuel ratio under a wide range of operating conditions. On the EEC IV system, the VAT sensor affects spark timing as a function of air temperature.

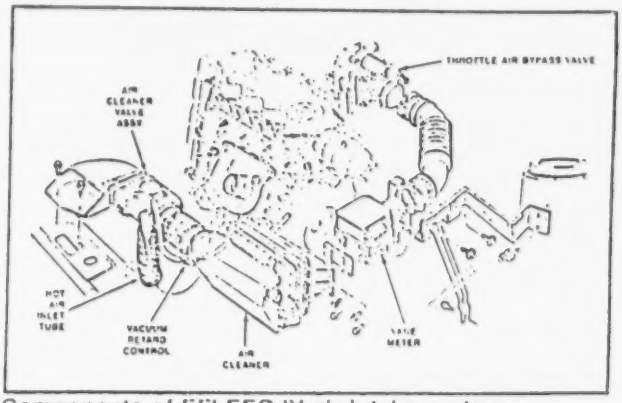
NOTE: Make sure all air intake connections are tight before testing. Air leaking into the engine through a loose bellows connection can result in abnormal engine operation and affect the air/fuel mixture ratio.

THROTTLE AIR BYPASS VALVE

The throttle air bypass valve is an electro-mechanical (solenoid) device whose operation is controlled by the EEC IV control unit. A variable air metering valve controls both cold and warm idle airflow in response to commands from the control unit. The valve operates by bypassing a regulated amount of air around the throttle plate; the higher the voltage signal from the control unit, the more air is bypassed through the valve. In this manner, additional air can be added to the fuel mixture without moving the throttle plate. At curb idle, the valve provides smooth idle for various engine coolant temperatures, compensates for A/C load and compensates for transaxle load and no-load conditions. The valve also provides fast idle for start-up, replacing the fast idle cam, throttle kicker and anti-diesel solenoid common to previous models.



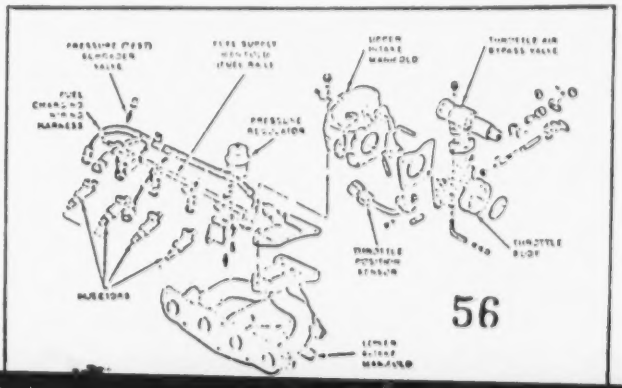
Components of EFI-EEC IV fuel system



Components of EFI-EEC IV air intake system

EXHAUST GAS OXYGEN (EGO) SENSOR

The oxygen sensor used on the EFI-EEC IV system is a new design, located between the two downstream tubes in the header in its own mounting boss. The sensor works between zero and one volt output depending on the amount of oxygen in the exhaust gas. A voltage reading above 0.6 volt indicates a rich fuel mixture, while a reading below 0.4 volt indicates a lean fuel mixture. Operation of the oxygen sensor is the same as similar systems used on other EEC and MCU



APPENDIX C

DATA FOR 1985

STUDENT	MATH LEVEL	READING LEVEL	AUTO GRADE	JOB RELATED	SATISFACTION LEVEL
1	6.9	5	1	NO	N/A
2	5.1	8	2	NO	N/A
3	7.8	9	8	NO	N/A
4	8.3	12	11	YES	5
5	7.9	9	8	YES	4
6	3.2	5	5	NO	N/A
7	5.7	8	8	YES	4
8	4.2	9	4	NO	N/A
9	3.9	7	8	NO	N/A
10	6.8	3	2	NO	N/A
11	7.4	5	4	NO	N/A
12	6.8	9	11	YES	5
13	7.1	6	4	NO	N/A
14	5.6	9	8	NO	N/A
15	8.1	12	11	NO	N/A
16	8.2	10	8	YES	5
17	3.1	3	2	NO	N/A
18	5.4	8	2	NO	N/A
19	7.8	11	11	NO	N/A
20	8.1	12	8	NO	N/A
21	6.1	6	4	NO	N/A
22	3.1	5	3	NO	N/A
23	4.7	2	2	NO	N/A
24	7.9	9	8	NO	N/A
25	8.1	11	8	YES	2
26	7.9	9	5	YES	4
27	6.1	6	4	NO	N/A
28	4.7	6	2	NO	N/A
29	7.6	11	11	NO	N/A
30	5.1	9	4	YES	5
31	8.3	12	8	YES	5

APPENDIX C CONTINUED

DATA FOR 1986

STUDENT	MATH LEVEL	READING LEVEL	AUTO GRADE	JOB RELATED	SATISFACTION LEVEL
1	7.9	9	5	NO	N/A
2	10.2	12	11	NO	N/A
3	6.1	7	4	NO	N/A
4	5.8	2	5	NO	N/A
5	7.3	6	8	YES	5
6	3.5	2	1	NO	N/A
7	4.8	7	1	NO	N/A
8	7.6	8	1	YES	1
9	9.8	9	0	YES	4
10	7.9	2	2	NO	N/A
11	8.1	9	8	NO	N/A
12	3.6	6	4	NO	N/A
13	4.8	5	5	NO	N/A
14	6.5	10	8	NO	N/A
15	11.1	9	4	NO	N/A
16	10.2	11	8	YES	4
17	7.8	8	4	NO	N/A
18	8.2	9	8	NO	N/A
19	8.9	8	5	YES	5
20	7.8	8	5	NO	N/A
21	4.7	6	11	YES	5
22	8.6	8	5	NO	N/A
23	10.1	9	5	YES	5
24	7.6	11	8	NO	N/A
25	5.8	7	4	NO	N/A
26	8.6	9	11	YES	1
27	7.9	7	5	NO	N/A
28	8.2	8	5	NO	N/A
29	6.8	5	4	NO	N/A
30	4.8	6	8	NO	N/A

APPENDIX C CONTINUED

DATA FOR 1987

STUDENT	MATH LEVEL	READING LEVEL	AUTO GRADE	JOB RELATED	SATISFACTION LEVEL
1	7.6	8	8	NO	N/A
2	8.2	6	8	NO	N/A
3	7.6	9	8	NO	N/A
4	8.9	8	2	NO	N/A
5	7.9	10	5	NO	N/A
6	8.2	6	5	NO	N/A
7	6.8	6	5	NO	N/A
8	10.2	9	11	NO	N/A
9	9.4	9	8	NO	N/A
10	7.8	5	5	NO	N/A
11	6.8	7	4	NO	N/A
12	4.5	5	2	NO	N/A
13	4.2	1	O	NO	N/A
14	8.2	8	8	NO	N/A
15	5.6	6	5	YES	1
16	10.2	9	8	YES	4
17	9.2	9	8	NO	N/A
18	5.7	8	8	YES	5
19	11.1	11	11	YES	5
20	7.5	8	5	YES	3
21	9.8	9	8	YES	5
22	8.8	9	11	YES	5
23	7.5	10	8	NO	N/A
24	8.1	9	11	NO	N/A
25	6.1	8	5	YES	5
26	7.6	8	5	NO	N/A
27	3.2	2	0	NO	N/A
28	6.3	11	8	NO	N/A
29	4.1	7	5	NO	N/A
30	6.7	8	8	NO	N/A
31	5.7	4	2	NO	N/A

APPENDIX C CONTINUED

DATA FOR 1988

STUDENT	MATH LEVEL	READING LEVEL	AUTO GRADE	JOB RELATED	SATISFACTION LEVEL
1	6.1	4	2	NO	N/A
2	10.2	9	11	NO	N/A
3	7.2	8	5	NO	N/A
4	6.5	8	5	NO	N/A
5	7.6	9	5	NO	N/A
6	8.7	7	2	NO	N/A
7	8.3	6	2	NO	N/A
8	5.2	5	4	YES	4
9	6.7	9	5	YES	5
10	7.8	9	8	YES	4
11	9.2	11	8	YES	5
12	6.2	7	2	NO	N/A
13	7.5	8	4	NO	N/A
14	8.1	11	8	NO	N/A
15	5.7	9	11	YES	5
16	7.8	9	8	YES	5
17	6.7	8	5	NO	N/A
18	8.9	9	11	YES	5
19	6.2	7	2	NO	N/A
20	7.8	6	5	NO	N/A
21	5.6	5	4	NO	N/A
22	7.9	5	5	NO	N/A
23	6.2	4	2	NO	N/A
24	6.4	6	5	NO	N/A
25	9.8	9	8	NO	N/A
26	10.2	9	8	YES	5
27	6.2	2	2	NO	N/A
28	6.4	6	5	NO	N/A
29	9.8	9	8	NO	N/A

APPENDIX C CONTINUED

DATA FOR 1989

STUDENT	MATH LEVEL	READING LEVEL	AUTO GRADE	JOB RELATED	SATISFACTION LEVEL
1	10.2	9	8	YES	5
2	6.2	2	2	NO	N/A
3	9.8	9	11	YES	5
4	3.8	4	0	YES	4
5	6.2	2	2	NO	N/A
6	7.6	6	5	YES	5
7	4.2	4	2	NO	N/A
8	7.2	4	4	NO	N/A
9	11.2	12	11	YES	5
10	8.9	9	8	YES	4
11	9.2	9	8	YES	5
12	7.6	8	5	NO	N/A
13	6.6	9	11	YES	5
14	7.6	5	5	NO	N/A
15	5.4	4	2	NO	N/A
16	8.6	9	5	YES	5
17	6.7	6	8	NO	N/A
18	7.8	8	5	NO	N/A
19	5.4	4	2	NO	N/A
20	7.1	9	8	NO	N/A
21	6.9	12	8	YES	5
22	6.8	7	1	NO	N/A
23	7.6	6	5	NO	N/A
24	8.5	4	2	NO	N/A
25	8.8	11	11	YES	5
26	4.1	2	2	NO	N/A
27	6.9	9	11	YES	4
28	9.5	12	11	NO	N/A
29	7.4	9	8	YES	4

Basic Skill To Be Focused On

Basic Skills Area: Reading

Specific Skill: Reading a reference manual

Job Related Example of the Above Skill
Using service manual to determine proper valve settings for a specific make and model of auto

Potential Areas of Student Difficulty in Fundamental Skills Related to the Sequence of Student Behaviors

- Unable to identify auto due to inability to recognize auto industry nomenclature (e.g., Rambler, Mustang, GTO, Pinto, Citation, Cherokee)
- Unable to locate parts manual due to inability to recognize parts of words (e.g., lubrication system, ignition system, differential)
- Unable to ascertain proper valve setting due to inability to interpret specification charts (e.g., intake - .005"; exhaust - .007")
- Incorrectly list valve setting due to inability to recognize and analyze compound words (e.g., rockerarm, locknut, intake)
- Unable to perform valve adjustment due to inability to analyze phrases, sentences, paragraphs on a work order from the chief mechanic

BASIC SKILLS LESSON IDEA

Context of Basic Skill Instruction

Vocational Area: Trade and Industrial
Program: Automotive Mechanics

Job Title(s) Auto Parts Store Employee
Garage Mechanic Trainee
Light Repair Mechanic

Sequence of Student Behaviors Needed to Perform the Job Related Skill

-Properly identify year, make, model of auto
-Locate appropriate service manual for identified auto
-Locate and interpret appropriate specification chart for valve settings for auto
-Properly list valve setting for use by the mechanic or customer
-Accurately perform valve adjustment on specified auto if so directed by chief mechanic

BASIC SKILLS LESSON IDEA

Suggested Instructional Strategies For Overcoming Potential Difficulties

-Worksheet to give students practice in looking up specifications for particular make and model of care. Student is to look up specifications and accurately record information.

-Fill out auto shop work orders and from these orders have student outline procedure to perform job. If possible have students actually perform work after procedure is established.

Common Instructional Materials
-Service Manuals
-Parts Books - parts order forms
-Shop work order forms
-Teacher made worksheets

Sketch of Teaching Aids

Fill in the appropriate specifications for each type of auto. You will be using auto manuals to find the specifications.

1. 1969 Ford Mustang, 6 cylinder

   a. Valve tappet settings _____
   b. Oil viscosity for engine _____
   c. Capacity of gas tank _____ gallons
   d. Spark plug gap _____

2. 1980 Chevy Citation

   a. ignition timing specifications _____
   b. breaker point setting _____
   c. capacity of cooling system _____ quart
   d. fanbelt size and number

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